Volume 16 November, 1930 *Number 11*

Lubrication

A Technical Publication Devoted to the Selection and Use of Lubricants

THIS ISSUE

The Paper Industry

Importance of Lubrication and Lubricating Equipment

PUBLISHED MONTHLY BY
THE TEXAS COMPANY
TEXACO PETROLEUM PRODUCTS

TEXACO RECOMMENDATIONS
PAPER MILL LUBRICATION

Saw Mill and Wood Room

Live Rolls Kickers and Niggers Splinter Guides Miscellaneous Bearings	*"A"*	TEXACO ALGOL OIL, OR TEXACO ALTAIR OIL
	"B"	TEXACO ALTAIR OIL TEXACO PELICAN OIL, OR TEXACO SUMMER OR WINTER BLACK OIL

Pulp Mill

Pocket Grinders Hand Operated	*"A"*	TEXACO CRANK CASE OIL TEXACO PELICAN OIL, OR TEXACO SUMMER BLACK OIL
	"B"	TEXACO 629 CYLINDER OIL TEXACO PELICAN OIL, OR TEXACO SUMMER BLACK OIL
Pocket Grinders Continuous	*Main Bearings*	TEXACO ALGOL OR URSA OIL, OR TEXACO ALTAIR OIL
Warren Voight and Warren Continuous Grinders	*Enclosed Reduction Gears*	TEXACO 650 T MINERAL CYLINDER OIL TEXACO 629 CYLINDER OIL, OR TEXACO PINNACLE MINERAL CYL. OIL
	Open Reduction Gears	TEXACO AXLE GREASE GRAPHITE
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Miscellaneous Bearings		TEXACO PRODUCTS AS SHOWN FOR SAW MILL AND WOOD ROOM

Chemical Pulp Mill

Sulfur Burners	TEXACO 629 CYLINDER OIL, OR TEXACO PELICAN OIL
Miscellaneous Bearings	TEXACO PRODUCTS AS SHOWN FOR SAW MILL AND WOOD ROOM

NOTE: *"A"*—Close fitting bearings, lubricated by ring or automatic oiling devices.
"B"—Bearings worn, loose or out of alignment; also hand oiled plain bearings.

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The Paper Industry

Importance of Lubrication and Lubricating Equipment

OF the several industries wherein quantity as well as quality production has become essential for our everyday needs, the manufacture of paper is of paramount interest, by reason of the extent to which its development has been dependent not only upon engineering ingenuity, but also our forest reserves. Paper, as it is known today is chiefly a product of wood pulp, although considerable research has been devoted toward the adoption of other forms of organic plant matter. As yet, however, our forests are the primary source of the innumerable grades of paper which we require.

At the present time, production of paper in the mills of the United States and Canada is in the neighborhood of 14,000,000 tons annually. It is difficult to realize the magnitude of this production, yet when we consider that upward of 3,000,000 h.p. are entailed, involving a consumption of over $77,000,000 worth of fuel per year, the vast importance of the paper industry can be appreciated.

In view of its dependence upon our coal reserves, our forests, and the efforts of the machine builders, paper can be said to occupy a position in industry paralleled only by iron and steel. There is an added contingency, however, just as in the latter industry, due to the relationship to machinery, viz.: the petroleum industry, which by virtue of its being the source of supply of lubricants, is the basic factor upon which the efficient production of paper hinges.

While this may not be entirely obvious to the layman it has been appreciated by the executives in the paper industry to the extent that cost of lubrication per ton of paper produced has become one of the standard factors in their production accounting schedules.

Efficiency Measured by Lubrication Cost per Ton

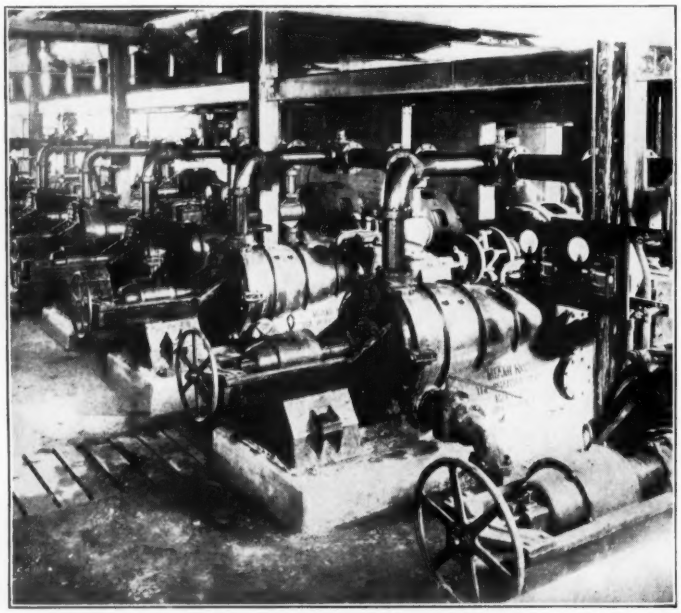
In consequence, cost of lubrication per ton may be said to be as carefully watched as cost per pound of steam generated. In fact, cost of lubrication is an even more important item, because if equipment is not properly lubricated power consumption may rise to such an extent as to increase the cost of steam produced per hour and the amount necessary for actual operation of the paper making machinery.

The paper industry is unique in that on much of the machinery involved either oil or grease may be used, by reason of the variety of bearing design and range of lubricating equipment which has been proven adaptable. The above, however, will more nearly hold true for older types of machinery, or where anti-friction bearings are involved. In certain of the more modern designs, decided attempt has been made to adopt as far as possible some practicable means of automatic oil lubrication, which will be capable of affording better and more dependable protection to the lubricants themselves against contamination.

On the other hand, contamination is not the only problem which may confront the paper mill executive in the attainment of effective

lubrication. In addition, he must consider pressure and temperature. In meeting the effects of the former pressure application of lubricants by some positive and preferably automatic means has proven to be of decided value. Obviously the counteraction of bearing pressure by a suitably maintained film of lubricant is an insurance of better sustained lubrication between the moving elements, and the prevention of possible metallic contact.

On the other hand, the viscosity, or body of the lubricant, plays an important part in such instances; normally where oil lubrication is provided for using the principles of circulation, lower viscosity products can be used by reason of the volume of oil circulated. Here the development of flood lubrication may be said to compensate in part for viscosity, or actual load-resisting ability. It must not be interpreted, however, that this holds true for any type of automatic circulating system. In the ring oiled bearing, for example, there is more or less flood lubrication, but the lack of pressure on the oil requires adequate viscosity, in accordance with the load imposed upon the bearing surface.



Courtesy of Shartle Brothers Machine Co.

Fig. 1—Showing an installation of Shartle Miami jordans, equipped with Timken roller bearings. It is essential that the lubricant in such bearings be not more than one and a half inches deep in the bottom of the housing, oil being used in preference to grease.

WHERE IMPROVEMENTS HAVE BEEN STUDIED

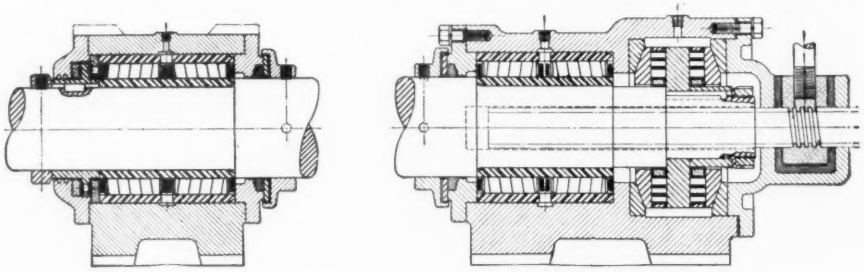
Distinctive improvements have been made, especially in the lubrication of beaters and washers, the paper machine itself, as well as calenders, during the past few years, for it has been realized that the operations of such machinery will have the most bearing upon cost of lubrication per ton of paper produced.

The intensive problems of high temperature and carbon formation, pressure, the possibility of entry of water and contamination of lubricants from other sources, have been primarily responsible for development of means of counteraction, in the realization that such conditions are the basic cause of impaired lubrication, wear of the parts affected, and increase in power consumption.

BEATERS AND WASHERS

On the beaters and washers the more or less inefficient methods of plain bearing lubrication by means of wool yarn grease or the use of felt rolls running in contact with the journals, have been supplanted by ring oilers, and the installation of suitable guards to prevent leakage of "stuff" into the bearing which would contaminate or wash out the lubricants.

The beater is essentially the first step in paper stock preparation, for it is here that the paper is actually "made," and brought to the necessary degree of hydration. Pulp, as it comes from the screens, thickeners and "wet machines," is still but one of the constituents of paper stock, requiring the addition of such materials as clay, sizing, alum and coloring



Courtesy of Hyatt Roller Bearing Co.

Fig. 2—Showing the application of a Hyatt D type bearing to a jordan engine. Inasmuch as the operation of a jordan depends on the proper fitting of the plug and may be altered by bearing wear, it is essential to use every care in the original choice of bearings and their subsequent lubrication.

matter before it can be regarded as ready for treatment by the jordan for the purpose of final cutting and mixing.

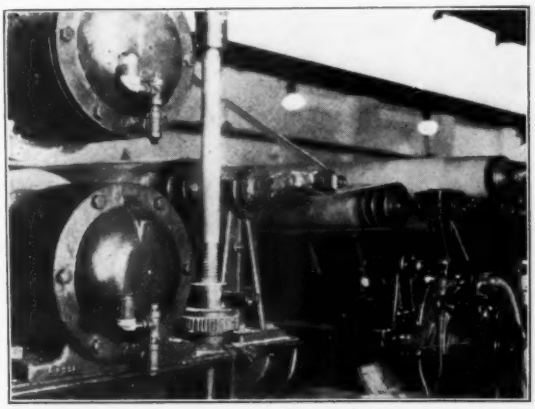
The function of the beater is that of mixing these constituents in proportion to the nature of the final product desired. The beater also serves to assist in cutting the pulp fibres to a length most suited to proper interlacing and forming on the paper machine. In this connection it is important to remember that although long fibres insure greater strength in the finished paper, if too long they may interfere with the proper operation of the paper machine. This treatment is accomplished by the beater roll, which is equipped with knife-like bars set longitudinally on the surface. This roll revolves within the beater or tub, over a concave bed plate equipped with a similar set of parallel blades opposed to those on the roll.

The Problem of Bearing Lubrication

The actual weight of the beater roll is the basis of the prevailing lubrication problem, involved in beater operation, by virtue of the pressures developed on the bearing surfaces. Except in more recent designs provided with some sort of shock absorbing device, beater bearings will still be found to carry plain bottom half bearings only, in order to accommodate the lifting action caused by masses of pulp passing between the roll and bed plate.

The beater bearing, whatever its type, is difficult to lubricate properly, due to the pressure resulting from possible alternate lifting and dropping of the journal. When this takes place water and pulp will tend to get into the bearing.

The use of suitable shock absorbers, however, and automatic means of lubrication, such as the wick oiler, will obviate the above to a large extent and minimize the detrimental results which would otherwise occur. When such construction prevails careful attention must be given to the choice of the lubricant. Experience has proven that a medium viscosity straight mineral product will meet the requirements if bearings are properly aligned and no excessive clearance prevails. Should wear have occurred, however, to increase this clearance it will be well to consider increasing the viscosity. Sometimes a light steam cylinder oil will serve the purpose, although if wear has developed to any marked degree it is not always safe to rely on viscosity alone to protect the bearings; readjustments would be the more logical procedure.



Courtesy of Power Service Company

Fig. 4—Showing the anti-friction bearing ends on the press rolls of a paper machine, wherein lubrication is maintained by an Oilit automatic lubricator.

Beater and washer bearings, on the other hand, cannot always be oil lubricated. On some types where open half bearings are involved, or where the tops are provided with recesses or pockets for pad lubrication, grease will frequently be preferred. In such instances a comparatively high melting point product should be used, which will not only develop a lubricating film of sufficient pressure resisting ability, but also withstand any washing out effect of water.

Courtesy of J. H. Horne & Sons Co.

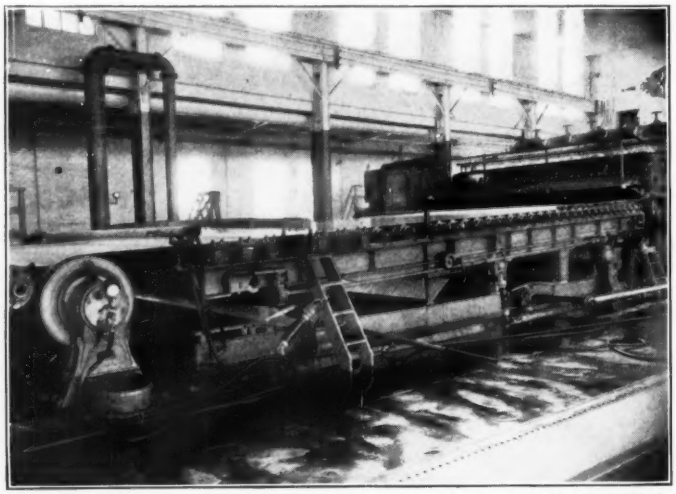
Fig. 3—Showing a typical iron tub Holland type beater. Quantity production is made possible only by continuous operation of such machines at uniform speed, which in turn can only be assured by effective bearing lubrication.

THE PAPER MACHINE

The paper machine has offered one of the most potential opportunities for improvement in means of lubrication and the adoption of more automatic means of application. In the average paper machine the range of operating conditions is decidedly varied, from the wet end, wherein there is excessive moisture and comparatively high pressure, to the dry end, where higher temperature conditions, heavier pressures and frequently high speeds prevail.

In the manufacture of lubricants to meet these varied conditions in a satisfactory manner, cognizance of the effect should be borne in mind during refinement. Too often an

attempt is made to attain economy by the choice of cheap, low grade products. Under many conditions these may function in an apparently satisfactory manner. On the other hand, inferior lubricants will seldom be able to meet the low carbon residue requirements entailed by high temperature, and the squeezing out effects of heavy load; therefore, they will tend to lead to impaired lubrication, although this may not be immediately evident.



Courtesy of Beloit Iron Works

Fig. 5—Showing the front elevation of a high speed newsprint Fourdrinier. This is equipped with anti-friction bearings, with provision for pressure grease lubrication.

It is for this reason that the paper machine has been so carefully studied in the interests of improving the means of lubrication. Design, too, has been taken into consideration in this regard, with the result that cams, for example, running in an oil bath are now preferred to exposed eccentric motions where reciprocating operations are to be developed.

Types of Construction

There are essentially two distinct types of paper machines, viz.: the Fourdrinier, which is most commonly used for newsprint and the other more familiar grades of paper, and the cylinder or vat machines on which paper board and tissue are produced.

WET END OPERATION—THE FOURDRINIER

From a general constructional point of view, it will be interesting to study the details of the Fourdrinier machine, especially since this is the most generally used throughout the industry.

Function of the Wire

One of its chief parts is the "wire," a fine copper or bronze mesh endless screen, onto which the paper stock flows from the head box. A partial function of this wire is to enable draining off of as much water as possible, as the former moves rapidly in the direction of flow. The regularity of motion of the wire is most important for upon this will depend the length of its life.

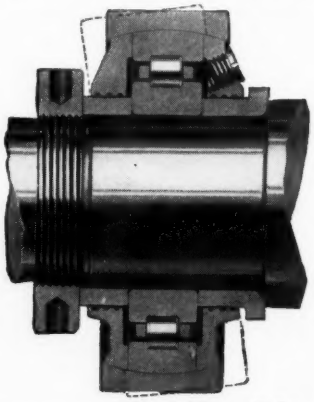
A series of parallel brass tube table rolls carry this wire and enable the formation of a flat table surface for the first stage in the making of paper. The first roll of this set is termed the breast roll. Below these rolls is located a trough which collects water drainage from the stock on the wire.

Partial Vacuum Also a Factor

After it has passed over the table rolls, the wire is led over suction boxes in which a partial vacuum is maintained, to aid in further removal of the water.

During the process of preliminary formation the embryo layer of paper in some types of machines is prevented from spreading or flowing off the edges of the wire by endless rubber belts, known as deckle straps; these are carried along by the wire. When this latter, with its layer of paper, reaches the last table roll, it passes its load under a light weight top roll, the function of which is to smooth the surface of the partially dehydrated sheet.

Prior to this, however, the stock has been passed between a set of couch rolls which lend the effects of pressure in the squeezing out of some of the water. By reason of the pressure which must be available on the top couch roll, its bearings must be so designed as to enable effective lubrication regardless of the pressure involved. Usually the bottom couch roll is connected through a clutch to a driving cone, serving thereby as the drive for this entire end



Courtesy of Norma-Hoffman Bearings Corp.

Fig. 6—Showing details of a self-aligning Hoffman precision roller bearing with closely fitting side plates. These exclude water and promote retention of lubricant. By virtue of this characteristic they are adaptable to the wet end of high speed paper machines.

of the machine. At the couch roll the web of paper is sufficiently bound together by its fibres to be capable of carrying its own weight.

Press Rolls the Next Stage

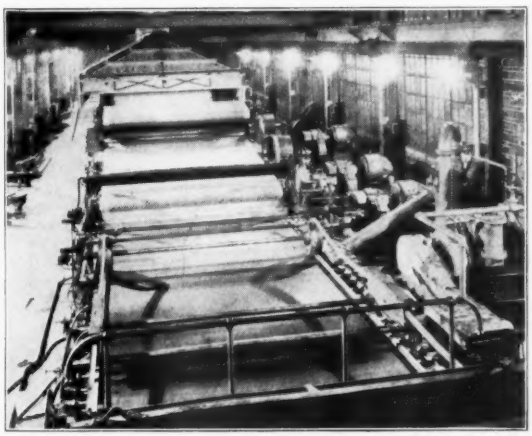
As a result, the web can now support itself, leaving the wire which is returned to the breast roll over return rolls located beneath the table rolls. The web, in turn, is passed to an endless woolen felt, which carries it between the press rolls. In order for this operation to be successfully maintained without tearing the web, the pull exerted by these latter rolls must be uniformly even and continuous. The number of these rolls will depend on the design of the machine, being two, three or more according to the duty to be performed.

Drive is maintained through the bottom roll, the top elements being weighted in a controlled manner to enable varied pressure, according to the amount of dehydration to be accomplished. These rolls include the problem of pressure in addition to that of water contamination of lubricants, which may prevail at the bearings of the earlier rolls of the Fourdrinier.

In higher speed machines suction is also included in connection with the press rolls. In such instances the suction element is known as a suction press roll. It is located below the sheet, serving also as a press roll. In general, the suction press roll carries a perforated shell, containing within itself a stationary suction chamber connected to a vacuum pump.

CYLINDER MACHINE OPERATIONS

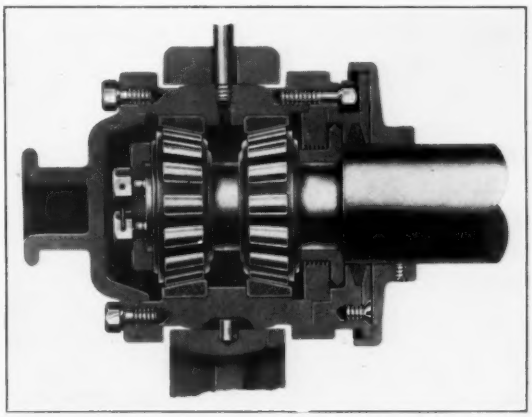
In contrast to the wet end operation of the



Courtesy of S. K. F. Industries, Inc.

Fig. 7—Top view of a Bagley and Sewall 136 inch paper machine, equipped with S. K. F. bearings. Note the respective location of the drive to the machine proper.

Fourdrinier, it will be of interest to note the constructional details of the cylinder or vat machine. This latter also employs a wire for the preliminary formation of the web by dehydration or draining. In this case, however, the wire is stretched on a cylindrical framework which rotates in a vat of paper stock. As the hollow cylinder roll revolves the fluid stock tends to flow through the wire mesh, leaving a deposit of fibrous material on the



Courtesy of Timken Steel & Tube Co.

Fig. 8—Showing a typical application of Timken bearings to a couch roll of a paper machine. Note in particular the means provided for retention of lubricant.

outer surface of the screen, the drainage flowing to a "save-all."

The difference in level between the water inside the cylinder and the paper stock in the vat develops sufficient suction to build up a considerable web or film of fibres on the surface of the rotating cylinder. This web is then picked up by an endless woolen blanket, or so-called bottom felt, being squeezed into close contact by a top couch roll. By suitable installation of additional cylinder rolls the web can be built up layer by layer, according to the final thickness desired. While this may involve somewhat of a variation in construction, the essential principles of operation are much akin to those of the Fourdrinier, and hence they present no real difference from a lubrication point of view, the question of resistance to water wash and pressure being the chief requirements to consider when selecting lubricants.

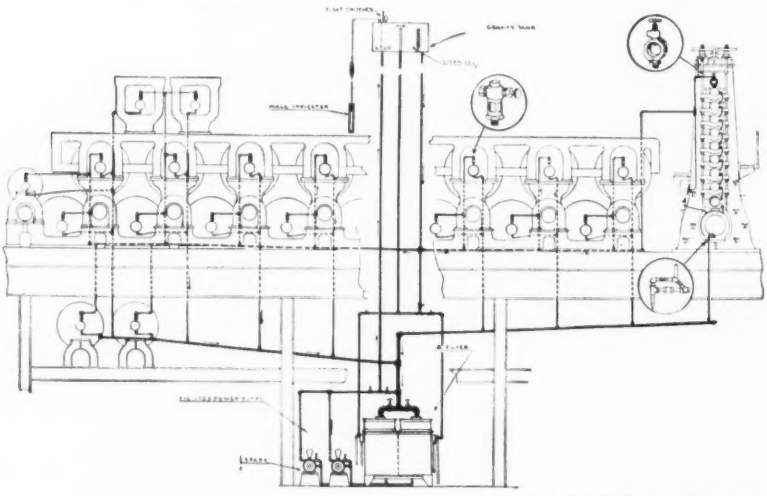
WET END LUBRICATION

There has been a decided tendency toward the adoption of anti-friction bearings or some method of automatic application of lubricants, in the development of the more modern types of paper machines. Without a doubt these improvements have reacted favorably upon the unit cost of lubrication per ton, as well as the cost of upkeep and repair, for they insure against entry of water in the operation of the various roll bearings, and enable the lubricants to resist the pressures involved more effectively.

The Use of Anti-Friction Bearings

On the wet end of certain types of machines the table rolls have been extensively equipped

with ball bearings designed for grease lubrication by means of individual pressure gun fittings. Roller bearings in turn have been found to be decidedly adaptable to press and couch rolls where pressures are higher than on the table rolls. Here, likewise, pressure grease lubrication has been adopted. The reason for this latter is obvious; were oil to be used, any leakage would lead to impaired lubrication, not only through possible loss of oil, but also entry of water, to result in rusting and corrosion of the bearing elements.



Courtesy of S. F. Bowser & Co., Inc.

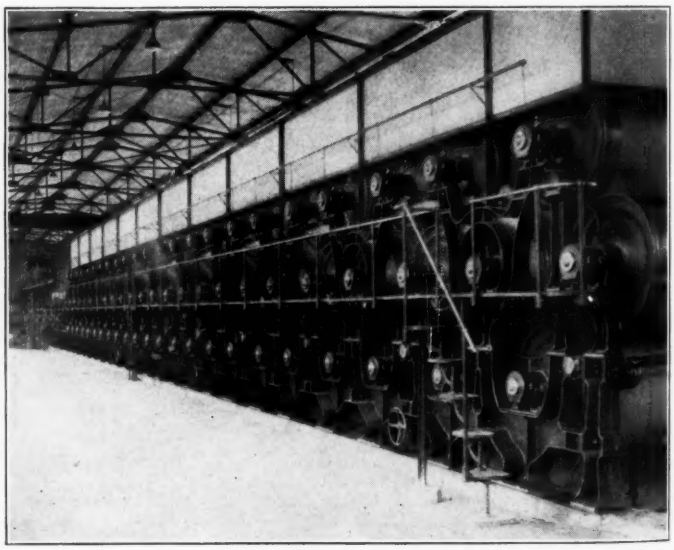
Fig. 9—Showing the lay-out of an automatic flood lubrication system for dryer and calender bearings. Note the oil pumps in duplicate, the filter and the arrows which indicate the path followed by the oil in its course through the bearings. In the upper right hand corner are shown typical sight feed oil controls.

Grease, on the other hand, by reason of the construction of such bearings, will normally remain within the latter and, furthermore, will serve as a seal to prevent undue entry of water. The relative solubility of a grease for such service, however, is important. Certain authorities regard a soluble soda soap product as an adjunct by reason of the fact that in the presence of normal amounts of water it will develop lubricating emulsions. There is no reason why this should be an advantage, if the use of lime soap products of average consistency is carefully carried out. In fact, properly compounded, a non-soluble lime soap grease will retain its original homogeneity and in the presence of average temperatures will afford a better water seal at the ends of the bearings.

Table Roll Operation

Whatever the design or the means of lubrication employed, the table rolls must be given careful consideration in the general lubrication of the wet end of the Fourdrinier. Where plain bearings are involved, grease lubrication has proven to be especially adaptable. On the other hand, regular application of a compounded oil of from 600 to 700 seconds Saybolt at 100 degrees Fahr., is also practicable and decidedly clean. The purpose of compounding is to enable development of a suitable lubricating emulsion with sufficient adhesiveness to resist the washing off action of water.

It is important to remember that in spite of the fact that table roll bearings will usually not be subjected to any abnormal pressure, and will operate fairly cool due to the presence of water, they may be a contributing cause to high lubrication and production costs should they tend to drag or stick, for this will ultimately cause flat spots in the roll itself, due to the friction of the wire. Obviously, continued operation under such conditions will not only entail expense, due to table roll replacement, but also it may seriously affect the quality of the paper at its most formative stage, interfering with uniformity; furthermore, abnormal wear will be developed on the wire itself, which usually is a costly item.



Courtesy of Beloit Iron Works

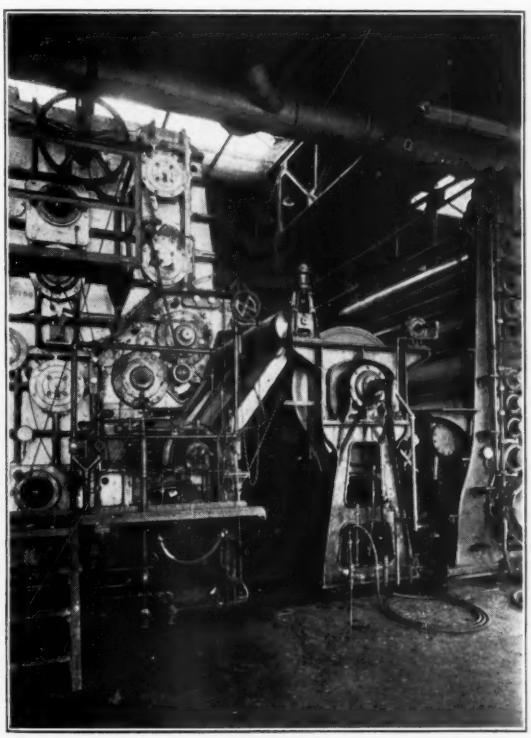
Fig. 10—Showing a three deck dryer section of a Beloit board machine. The bearings on this device are lubricated by a continuous gravity oiling system.

All this will lead to uneven tension on the wire, inasmuch as drag on the table roll bearings will react on the drive, which is ordinarily accomplished through the lower couch roll. Uneven pull with any accompanying wear or tendency in the wire to twist out of shape will ultimately necessitate replacement of this element.

Wick Feed Design

On plain bearing rolls an automatic wick feed and reservoir oiling device will frequently be the solution of any lubrication problems, for it will not only insure automatic readily controlled delivery of oil, but also will largely eliminate the uncertainty due to the human element where individual lubrication is necessary. In fact, by use of a manifold and circulating system, the operator will be almost entirely relieved of the necessity to attend to such bearings, except where the oil reservoir is to be refilled or the wick stripped.

In this connection it is important to remember that the use of a compounded oil will require stripping or cleaning of wicks at periodic intervals to prevent gumming, which would ultimately lead to impaired lubrication should the pores of the wicks become entirely clogged. For this reason also, the oil should not be too viscous or heavy in body.

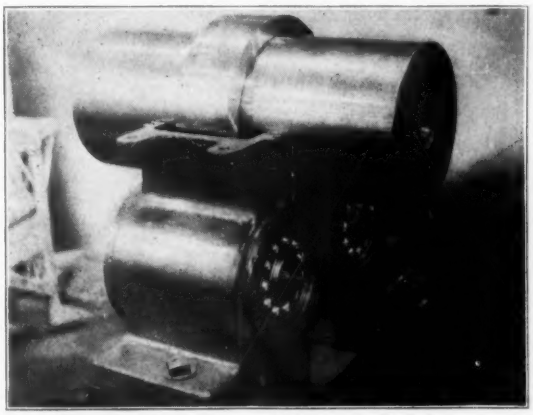


Courtesy of Minton Vacuum Dryer Corp.

Fig. 11—Showing the calender end of a Minton Vacuum dryer. Note in particular the manner in which bearing ends are protected against entry of contaminating foreign matter.

FELT ROLL BEARINGS

There is further room for improvement, however, on some paper machines, especially in regard to felt roll bearings. These are sometimes still of the plain sleeve type, with the upper half removed, and, therefore, exposed to water. It is the opinion of certain authorities that this condition could be met by the use of full bearings, equipped for ring-oiled lubrication, or the design of bearing caps of sufficient size to permit application of wool yarn grease in a suitable reservoir.



Courtesy of S. K. F. Industries, Inc.

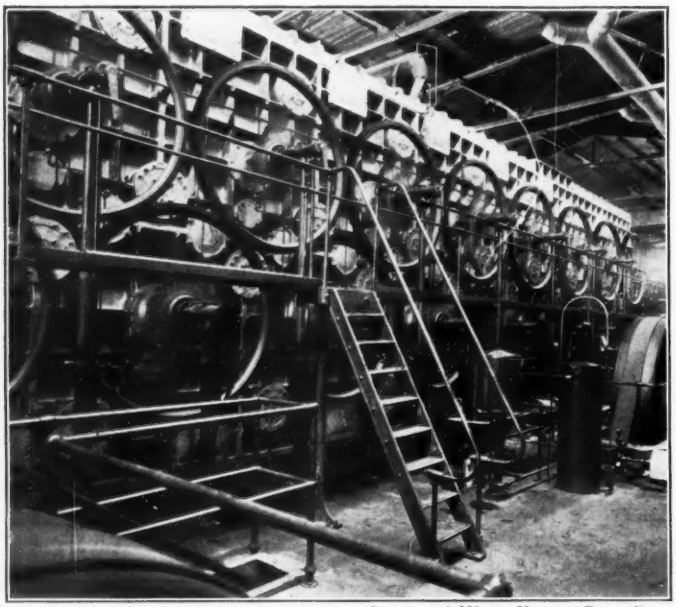
Fig. 12—Showing details of construction of a dryer cylinder antifriction bearing mounting.

The choice of the lubricant in actual service will, of course, depend upon the construction of the bearings; this will apply to couch and press roll bearings as well as those of the felt roll. When these elements have comparatively low clearances and can be regarded as tightly fitting, where automatic means of oiling are employed, a straight mineral oil of about 500 seconds Saybolt at 100 degrees Fahr., should give satisfactory service. In cases where water may gain entry, however, the use of a compounded oil which will emulsify on contact with water will be best. Its viscosity should be somewhat higher than quoted above to insure adequate lubrication. These same requirements will hold true for worn or loose fitting bearings, or where hand oiling is practiced.

In the study of couch roll bearing lubrication, in turn, it is important to remember that where oil is delivered through the top bearing cap this latter must be properly grooved to permit of adequate circulation of the oil, in order that the existing pressure may be properly counteracted by a positive film of oil, and not allowed to be the cause of actual metal-to-metal contact.

It is, of course, also practicable to use wick, chain or ring oilers on these bearings just as elsewhere in the mill. With the latter types, straight mineral oils within the proper viscosity

range are generally suggested. Circulation prevails here, and normally such bearings are built comparatively water-tight. It must also be remembered that the formation of emulsions in enclosed lubricating systems of this nature may become a detriment to free oil circulation.



Courtesy of Minton Vacuum Dryer Corp.

Fig. 13—Showing the relative location of the driving elements to the roll bearings of a paper machine.

In the wick oiled bearing, however, emulsion formation will frequently be the only positive means of assuring dependable lubrication, especially where water contamination may be prevalent and bearing construction is not such as to prevent its entry entirely.

This thought also holds true for grease lubrication, although the same premise exists as discussed in the case of table roll bearings. In other words, the lubricant must be of such a nature as to resist the washing off action of water. Frequently, soda-soap greases capable of developing a certain amount of emulsion will be best, although a non-soluble lime soap product, if it can be properly retained in the bearing, will perhaps give more complete lubrication with somewhat less internal friction, for it must be remembered that emulsions, by virtue of their adhesive tendencies, may require more power in the actual operation of the rolls.

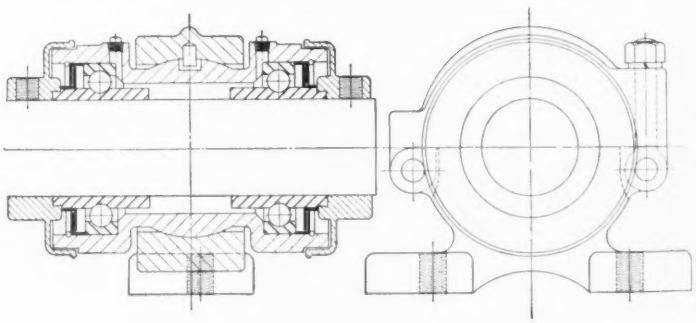
THE PROCESS OF DRYING

The paper sheet as it leaves the wet end of either a Fourdrinier or cylinder machine, after passing through the press rolls still contains at least sixty per cent water. It must, therefore, be subjected to a series of drying operations to render it comparatively air dry. The process of drying involves a continuation of the rolling action already begun on the wet end. At the dry end, however, the roll mechanisms consist of a series of hollow cast iron cylinders, heated internally by steam. On certain types of machines there may be from fifty to one hundred of such dryers.

These elements are built to run in synchronism, being geared together in order to function in absolute unison with each other, thereby subjecting the sheet to virtually constant tension. The sheet is passed to the first set of dryers directly from the press or felt rolls.

The arrangement of the dryers has a good deal to do with the finished surface of the paper. A method of developing a glaze is to operate one large roll of this nature in conjunction with a series of smaller press rolls. To a certain extent this anticipates the function of the calender stack.

Whatever the nature of construction, however, it is important to remember that effective steam joints are decidedly essential, for leakage must be prevented as far as possible. The use of steam for the purpose of drying is analogous to other branches of industry, notably the textile; one is therefore confronted with much the same problem; viz.: the possibility of damage or staining of the product being handled. This may be developed if steam leakage occurs, due to the oil content of the steam, es-

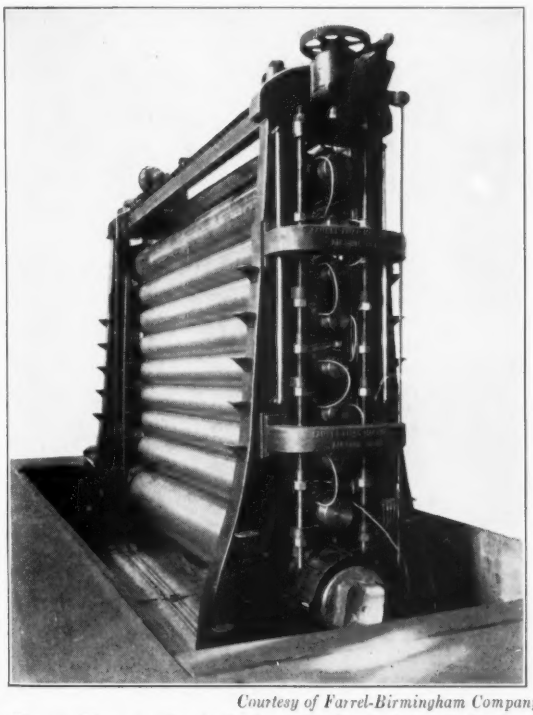


Courtesy of The Fafnir Bearing Co.

Fig. 14—Details of a ball bearing applied to a couch roll, showing construction of the component parts and means for sealing.

pecially where exhaust steam may be passed to open type feed water heaters and subsequently returned to the boilers without adequate removal of any cylinder oil which it may contain. Obviously the resultant live steam may carry over a certain amount of this oil to the dryers, greatly reducing the efficiency of drying.

All steam joints must be carefully checked in order that leakage is corrected as soon as possible, but they should never be screwed up so tightly as to cause wear. Steam joints can be adequately protected by cylinder oil or grease; the use of either, properly applied to the faces of the moving parts, will insure proper lubrication, the prevention of wear and consequently steam leakage. Steam joints present one of the greatest potential power consuming elements in the paper industry. The grade of steam cylinder oil employed elsewhere in the plant will usually be satisfactory for such joints.

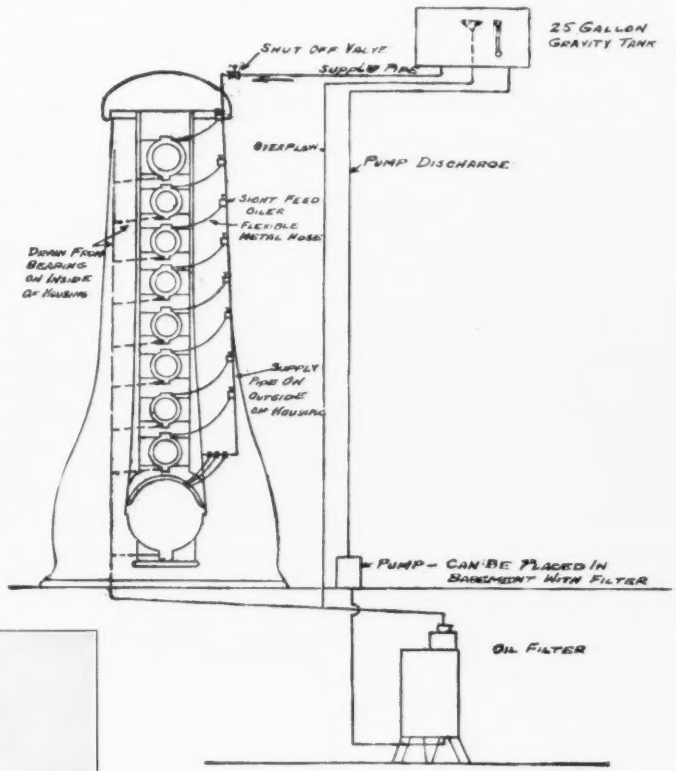


Courtesy of Farrel-Birmingham Company

Fig. 15—View of a Farrel calender stack, showing in particular the oil leads to each bearing and the component parts of the circulating oiling system. The relative size of the stack can be observed by noting the size of the man at the base.

Lubrication Problems Involved

From a strictly lubrication point of view, however, there are other problems. In effect these involve the questions of high temperature and pressure. Fortunately, however, speed is not much of a factor. On the other hand, inaccessibility must be given due consideration, for the bearings on the back or steam side are frequently almost impossible to reach, due to the driving gears. As a result, some means of automatic lubrication is decidedly essential.



Courtesy of Farrel-Birmingham Company

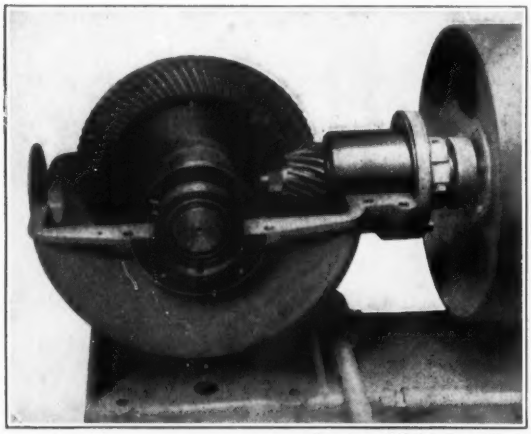
Fig. 16—Details of a calender stack oiling system, showing the lay-out of the pipes and the essential fittings involved. In this system oil is pumped from a filter to a gravity tank located above the stack, from which oil is circulated to the roll bearings as shown.

Systems of Lubrication

In some instances a combination of the wick feed oiler and waste pad will serve the purpose, where plain or sleeve type construction prevails, especially if the top bearing is built with a suitable recess or waste pad pocket. Under such conditions the wick oiler will automatically deliver the requisite amount of oil to the pad to maintain dependable lubrication. By designing such systems so that the pad end of the wick is lower than the end immersed in the oil reservoir, the principles of both capillary and syphonic action are used to good advantage.

Other types of such bearings will be designed for ring or collar oiling and still others, on more recently designed machines, will involve anti-friction bearings. The use of the ring or collar oiler in conjunction with an automatic oil circulating system is particularly noteworthy,

for circulation if properly accomplished will insure against over-heating, the flood of oil acting as a cooling or heat removing medium. Furthermore, means of filtration and cooling are frequently installed with such systems to



Courtesy of Beloit Iron Works

Fig. 17—A Beloit spiral bevel gear unit, with top housing removed to show the gears and anti-friction bearing elements. Thorough lubrication is developed by means of splash, the oil being conducted to the bearings through large channels.

give the further advantage of clean cool oil. There is also a decided element of dependability involved, for in case there should be any interruption of oil flow due to breakdown of the circulating system, or should it have to be cut out temporarily for minor repair or adjustment, the capacity of the bearing reservoirs and the automatic action of the rings or collars in maintaining oil circulation will insure dependable and continued operation for a considerable length of time.

If it is not practicable to install an extensive circulating system, however, somewhat the same results will be attained by using a wick oiler in conjunction with each ring or collar by means of a simple piping arrangement to a common manifold.

Effect of Impaired Lubrication

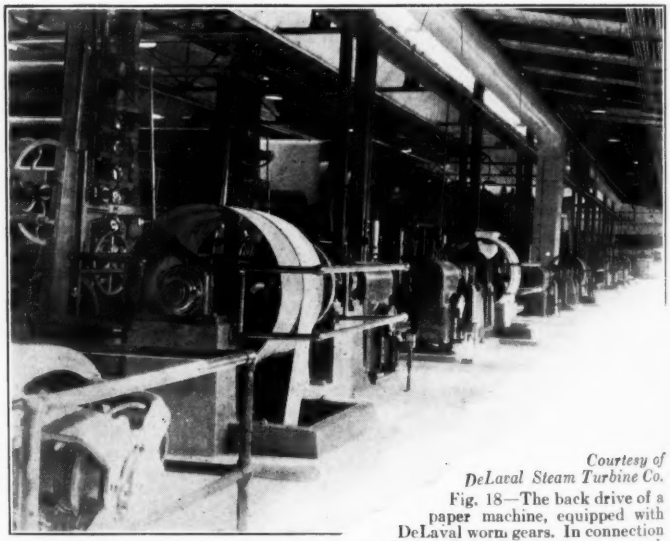
Whatever the system of lubrication, it is important to remember that neglect of the back end bearings on any dryer may cause the cylinders to sag, which will in time necessitate undue expense for repair as well as loss of time during the period of shutdown.

These conditions will be prevented, however, if due care is given to study of the several means of lubrication available according to bearing construction, and the choice of a suitable grade of oil. To meet the pressure and temperature conditions this latter should normally be of comparatively heavy body, ranging from 60 to 170 seconds Saybolt at 210 degrees Fahr., according to the condition of the bearings, the means of application and the temperatures. Ease of distribution is important and might be regarded as the outstanding requirement. On the other hand, the more fluid the product the more readily will it vaporize when exposed to comparatively high temperatures.

Paper Mill Back Drives

Lubrication of the back drive of the paper machine requires careful consideration. On the older type of machine the bearings are of the plain sleeve type, designed for ring or chain oiling, or grease lubrication. To meet the average operating conditions which these will involve, an oil of approximately 500 seconds Saybolt viscosity at 100 degrees Fahr., is preferable. Under high speed operation, however, especially where unusually tight belts may be involved, a heavier oil or even a wool yarn grease may be necessary. For this reason, the tendency has been to adopt the anti-friction bearing in more up-to-date back drive construction. This has been proven extremely adaptable and has eliminated lubrication difficulties to a marked degree.

In regard to the clutch, it is well to state that the magnetic type has of recent years come to replace the older forms of clutch design. In such installations it will be best to use a medium consistency grease, not only for the anti-friction bearings but also for the quills of the clutches, for in the use of oil there will be a chance of its finding its way to the clutch faces and also to the belts to cause slippage.

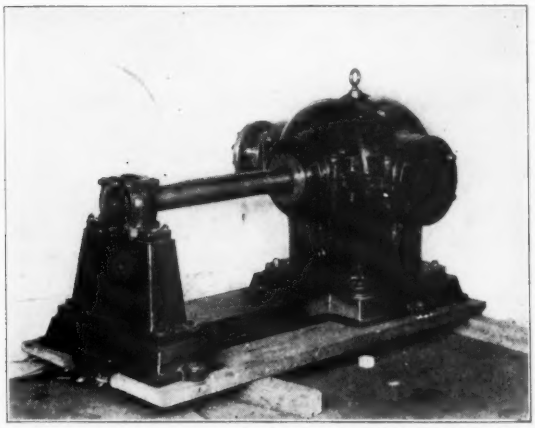


Courtesy of DeLaval Steam Turbine Co.

Fig. 18—The back drive of a paper machine, equipped with DeLaval worm gears. In connection with the oil circulating system on such an installation an oil purifier will prove a distinct adjunct.

CALENDER STACKS

A high finish or glaze is imparted to the paper after it leaves the dry end of the paper machine proper by passage between a stack of calender rolls. This is virtually an ironing process; the



Courtesy of J. H. Horne & Sons Co.

Fig. 19—A Horne bevel gear drive box in which the gears are entirely enclosed, which makes operation in an oil bath possible.

operation is known as super-calendering. By it the paper is subjected to high pressure, at a speed commensurate with the nature of the desired finish. Normally the higher the finish the greater will be the pressure and the higher the operating speed.

In the average stack there will be from seven to eleven rolls. While the size of these elements will vary, of course, in general the top and bottom rolls will be the largest, the intermediate being of somewhat less diameter, and consequently not so heavy.

It can be appreciated that by virtue of the heavy duty involved, wherein both pressure and speed must be considered, the bearings of the average calender stack will present a decided problem of lubrication. While this has been realized for a long time, it is only comparatively recently that concerted study has been given to developing a satisfactory solution, in the form of circulating flood lubrication.

In older installations continuous lubrication was brought about to a certain extent by delivering oil to the bearing of the topmost roll, the drainage from this element passing to the next below and so on down to the bottom. By reason of the lack of pressure on the oil supply, however, as well as the usual limited amount which could pass through the bearings, there was but little actual protection of lubrication. In other words, entry of contaminating dust to any extent would tend to accumulate in the bearing oil grooves rather than be washed out. Development of such obstructions to any marked degree could naturally be expected to impede the flow of oil, frequently, as experience has proved, to the serious detriment of the bearings.

Study of circulating systems of lubrication, however, has indicated that the flood of lubricant developed by leading oil under sufficient pressure and in adequate volume to each respective bearing will effectively protect them from accumulation of non-lubricating matter by virtually washing this latter out during circulation of the oil. To insure that the oil will be of sufficient purity for continuous usage, however, proper means of filtration must be installed with such a system to remove any foreign matter as may be carried out by the return oil.

Lubrication an Adjunct to Cooling

An added feature of such means of lubrication involves cooling. While steam heated rolls are not used throughout the entire calender, the pressures of operation and crowding frequently develop considerable temperature. To an extent this will be conducted to the bearings, or in low clearance elements actually generated therein. By serving them with a flood of oil, however, lubrication as well as cooling is brought about, the return oil carrying away a considerable amount of heat, which is subsequently dissipated in the filter and storage tanks, prior to re-circulation of the oil.

To further increase the benefits pertinent to circulating flood lubrication ring or collar oilers are also adapted to modern calender bearings. The combination of these means of lubrication has been discussed in detail in connection with the dry end of the paper machine. Suffice it to say that the same advantages exist in the case of the calender.

Bearing Design

In the construction of calender roll bearings, experience has indicated that careful attention must be given to the bottom roll. Here clearance is very important; obviously it must never be too great, otherwise there would be possibility of appreciable reduction of the contact area to result in an increase in unit operating pressure. This has also been the reason for careful study of oil grooving of such bearings.

As an adjunct to design, the manner of applying lubricants to these bottom roll bearings is also important. In the opinion of certain authorities a direct lead from the oil distribution main to each of such bearings will insure the continuous delivery of cool, fresh oil, and a more effective counteraction of the cumulative pressure exerted by the entire set of rolls which comprise the stack. On the other hand, the oil outlet must be of ample size to carry off the oil discharge, and relieve the bearing of any possibility of back pressure or crowding. This can be helped by carrying the oil grooves to the point of discharge in the bearing proper.

Motor Oil Viscosity Numbers

In the discussion of the suitability of any motor oil as a lubricant for the modern automotive engine the question of viscosity or body must always be considered. Strictly speaking, this is a physical characteristic, indicative of the relative fluidity of any oil at a specific temperature of observation. Unfortunately, however, it has been but little understood by the average motorist, for its true meaning has been clouded by attempts to popularize such terms as light, medium, heavy medium, heavy, etc., according to the brand of oil involved and respective refiner's opinions as to the range of viscosity each term should cover.

In this regard, on the other hand, there has been but little cooperation on the part of many refiners. As a result, individual conception of the viscosity range which any of these terms should embrace has varied widely.

Many motorists have suffered the cost of unjustifiable engine difficulties for this reason, especially where they have chosen motor oils for their face value only.

There is, however, more to the selection of motor oils than the mere idea that the term "heavy" should apply to comparatively warm weather service, and conversely the terms "medium" or "heavy medium" to low temperatures. A precise knowledge of the actual viscosity range as physically expressed is required. This, however, may be misunderstood by some.

For this reason the Society of Automotive Engineers has recently standardized upon a system of grading in the interest of a more intelligent understanding of the importance of the right viscosity for any set of engine or operating conditions. By concurrence with this system, the Petroleum Industry has shown its broad-minded interest in co-operation, to the end that now the motorist is assured of a standardized viscosity nomenclature, irrespective of his preference in regard to brand of oil or its source of refinement.

The automotive manufacturers also have indicated their approval of this system of numbering by adopting it for the recommendation of engine lubricants in their instruction booklets.

CRANKCASE LUBRICATING-OIL VISCOSITY NUMBERS
S. A. E. Recommended Practice

Viscosity Number	VISCOSITY RANGE SAYBOLT UNIVERSAL, SEC.	
	At 130 Deg. Fahr.	At 210 Deg. Fahr.
10	90–120	.....
20	120–185	.....
30	185–255	.....
40	255–	–75
50	.....	75–105
60	.....	105–125
70	.....	125–150

In the case of prediluted oils, S. A. E. Viscosity Numbers by which the oils are classified shall be determined by the viscosity of the undiluted oils.

Wherever the S. A. E. Viscosity Numbers are used on prediluted oils, the container labels should show in some suitable manner that the S. A. E. Number applies to the undiluted oil.

The S. A. E. Numbers constitute a classification of crankcase lubricating oils in terms of viscosity only. Other factors of oil quality or character are not considered.

This S. A. E. system is based upon numbers, as indicated by the accompanying chart. As noted the measured viscosity in seconds by the Saybolt Universal Viscosimeter is taken at 130 degrees and 210 degrees Fahr., to provide a knowledge of the relative change in fluidity between average operating crankcase temperatures.

Obviously the adoption of this system will go far to eliminate the necessity for using descriptive terms such as light, medium, heavy etc., which at best have proven decidedly misleading. On the other hand, the motorist must remember that S. A. E. numbers cannot be taken as a criterion of quality. The reputation of the individual refiner must be depended upon in this regard.

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